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February 14, 2017

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Subject:
48.0 hour High-Vacuum Remediation Event #2 & #3
Ocean Petroleum
1025 Bay Street
Brunswick, Georgia
Fruits Project: GA17-7504

Dera Mr. Moore:

Fruits & Associates, Inc. is pleased to provide this summary of the High-Vacuum Remediation event that was conducted on January 23rd and 24th, 2017 at the above referenced facility. Below is a summary of both the technology as well as the results of the actual event.

Technology:

High-Vacuum Remediation (HVR) involves the extraction of subsurface vapors and liquids via a monitoring well or recovery well. This is accomplished by applying high levels of vacuum pressure to the extraction point. To eliminate mounding of the water table, a drop tube (commonly known as a stinger) is inserted in the well to the static water level depth. The applied vacuum and airflow extracted from the well is pulled through this drop tube. As the water table attempts to mound due to the application of vacuum, the liquids are “slurped” through this drop tube. This slurping effectively maintains the static conditions of the water table while the elevated vacuum is applied to the well during the event. In order to minimize any change to the current smear zone associated with the site, seasonal water level data is analyzed. Once the extraction process is underway, the inlet of the stinger assembly is slowly lowered to the maximum historical water level observed for each extraction well. This draw down (one to ten feet below the static water level) depresses the water table and creates a cone of influence, which maximizes the efficiency of the high vacuum process.

Occasionally, fresh air (5 to 25 CFM) is introduced at the well surface to increase the airflow and enhance the liquid removal rate. In order to accurately record the actual removal rate from the well, an airflow gauge is mounted on the well head to measure the amount of fresh air that is introduced. This extra fresh air is subtracted from the total flow calculated for each extraction well. Additionally, two vacuum gauges are installed; one on the stinger assembly (well head vacuum), and one on the well casing (influence vacuum). If fresh air is introduced at the well head, the influence vacuum reading will be artificially lower than the actual applied vacuum because the inlet for fresh air is adjacent to this vacuum gauge port. The setup and piping configurations are shown in Figure #1.

During the extraction process, the combined air and liquids are transferred to the mobile treatment system where the liquids are separated with a liquid scrubber / knockout system and discharged into a storage tank for future disposal. The hydrocarbon vapors are transferred to the off-gas treatment system and are incinerated in a forced air Thermal Oxidation (ThOx) unit at 1500 degrees Fahrenheit. After thorough destruction of the contaminants in the air stream, the clean air is discharged into the atmosphere. A complete flow diagram of this process is shown in Figure #2.

Calculations:

During the HVR event, two measurements are taken, of both the influent and effluent flow rates, the concentrations of the vapors removed (before off-gas treatment), and the off-gas treatment system concentrations. These measurements are used to calculate the removal rates and the off-gas emission rates. The flow rates were measured using a Dwyer DS-300 Pitot tube attached to a differential pressure gauge. These flow rate measurements are reported in Actual Cubic Feet per Minute (ACFM). Before each event, these flow assemblies are calibrated to insure an accurate flow measurement. A separate flow rate is calculated for each influent well (if more than one well is connected), as well as for any additional fresh air that is introduced into the influent stream. The individual flow rates are combined to achieve the total flow and velocity derived from the extraction points. Because of the extremely high concentrations involved with a High Vacuum event, additional quench air (0 to 2,000 SCFM) is added to the vapor stream, just before entering the ThOx unit. An additional Pitot tube assembly is installed at the inlet of the ThOx unit and is used to measure the total flow. Combined with the off-gas concentration readings, this total flow rate is used to calculate the destruction efficiency of the system.

The concentration measurements are taken using a TVA-1000A FID instrument calibrated to methane. For comparison purposes, the removal rates are calculated in total carbon, as well as total hydrocarbons. This FID instrument has a dynamic range of 0-50,000 PPM as methane, 0-100,000 PPM as hydrocarbon. Our concentration samples are collected before any additional bleed or quench air is added to the extracted flow rate. These undiluted concentration measurements exceed the dynamic range of any FID instrument. In order to accurately record the high concentrations observed during a HVR event, a calibrated 10:1 dilution valve is used to cut the sample. This dilution valve, along with the FID instrument, is calibrated before the start of each event.

In order to eliminate the naturally occurring methane that is present during a typical HVR event, each concentration sample is measured twice. The first sample is collected directly from the system, and recorded as the total VOC concentration. The second sample is collected using an in-line activated carbon filter, which adsorbs the hydrocarbon compounds leaving only methane present in the sample to be measured. This methane only result is then subtracted from the total VOC concentration measurement (first sample), resulting in a Non Methane Organic Compound (NMOC) concentration. This NMOC concentration is used in the mass removal calculations. However, as with any FID instrument, the NMOC results are recorded as parts per million by volume (PPM_v) as if the concentrations were methane. A conversion from methane to a hydrocarbon and from a volume to a weight is necessary to calculate an accurate mass removal rate. Using the NMOC concentration results and the TVA-1000's factory certified response ratio for hydrocarbons, the NMOC results are converted to equivalent hydrocarbon mg/Ls. A TVA-1000 FID has an average response ratio of 600 PPM_v per mg/L of unleaded gasoline and 200 PPM_v per mg/L of diesel. Summaries of these calculations are shown in Figure #3.

Results:

Phase Separated Hydrocarbon (PSH) was detected in monitoring wells MW-9 (0.03 feet) and MW-10 (0.02 feet) prior to performing the event (well locations are shown in Figure #4). Once static water levels were established, during the course of the event the system was connected to MW-10, MW-9, MW-1/MW-10 (combined), MW-3/MW-9 (combined) and MW-4/MW-5 (combined). At each of the extraction points a stinger was located at the static fluid levels, and once the ThOx unit's normal operating temperature was reached, the inlet flow valve was opened for these wells. Once the PSH was removed from the extraction wells (if any), the stinger assemblies were lowered into the static fluid level approximately 0 to 1 feet, creating a cone of influence.

During the first 24.0 hour HVR event (event #2), the average ACFM was calculated at 33.10 for MW-10, with an additional 5.00 ACFM recorded at the fresh air breather port. The fresh air breather port is used during an event to enhance the volatilization and fluid recovery rates from the monitoring wells. Additionally, 29.08 ACFM was calculated for MW-9 with 5.00 ACFM recorded at the fresh air breather port, 28.58 ACFM was calculated for MW-1/MW-10 with no ACFM recorded at the fresh air breather port, 16.50 ACFM was calculated for MW-3/MW-9 with no ACFM recorded at the fresh air breather port and 23.34 ACFM was calculated for MW-4/MW-5 with no ACFM recorded at the fresh air breather port. A summary of the recovered flow rates are shown in Figure # 5. The combined total airflow from the extraction wells and breather ports averaged 70.30 ACFM.

During the last 24.0 hour HVR event (event #3), the average ACFM was calculated at 43.29 for MW-10, with no additional ACFM recorded at the fresh air breather port. The fresh air breather port is used during an event to enhance the volatilization and fluid recovery rates from the monitoring wells. Additionally, 52.52 ACFM was calculated for MW-9 with no ACFM recorded at the fresh air breather port. A summary of the recovered flow rates are shown in Figure # 5. The combined total airflow from the extraction wells and breather ports averaged 95.81 ACFM.

Throughout the event, air concentration measurements were recorded periodically from both the influent and effluent sample ports. The concentration results were entered into the HVR field monitoring log (Attachment A) and during the event, 2383.66 pounds of carbon was removed (7955.69 pounds of hydrocarbon, 1291.51 equivalent gallons of gasoline). Additionally, 133.84 pounds of methane was removed and incinerated during the event. A summary of the total equivalent hydrocarbon recovery rate is shown in Figure #6. The total off-gas discharge (to the atmosphere) was 0.17736 pounds of carbon (0.59197 pounds of hydrocarbon), thus yielding a 99.99% destruction rate for the ThOx unit. Induced vacuum readings (in inches of water column) were recorded in this event (See Attachment A for results).

Once the HVR event was complete, a second round of water level measurements was recorded in which the results are shown in Attachment A. After the event, there were no levels of PSH recorded in any of the associated monitoring wells. During the event, 1,425 gallons of petroleum contacted water (PCW) was removed and disposed of on site.

Sincerely,

Fruits & Associates, Inc.

John M. Fruits

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